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Nutrient intakes and dietary patterns of young children by dietary fat intakes

Carol Ballew, PhD, Sarah Kuester, MS, RD, Mary Serdula, MD, MPH, Barbara Bowman, PhD, and William Dietz, MD, PhD

Objective: To determine whether low fat intake is associated with increased risk of nutritional inadequacy in children 2 to 8 years old and to identify eating patterns associated with differences in fat intake.

Study design: Using 2 days of recall from the Continuing Survey of Food Intake by Individuals (CSFII), 1994 to 1996, we classified 2802 children into quartiles of energy intake from fat (<29%, 29% to 31.9% [defined as moderate fat], 32% to 34.9%, and ≥35%) and compared nutrient intakes, the proportion of children at risk for inadequate intakes, Food Pyramid servings, and fat content per serving across quartiles.

Results: More children in quartile 2 were at risk for inadequate intakes of vitamin E, calcium, and zinc than children in higher quartiles ($P < .0001$); more children in quartiles 3 and 4 were at risk for inadequate intakes of vitamins A and C and folate ($P < .001$). Fruit intake decreased across quartiles ($P < .0001$); whereas vegetable, meat, and fat-based condiment intakes increased ($P < .0001$). Fat per serving of grain, vegetables, dairy, and meat increased across quartiles ($P < .0001$).

Conclusions: Moderate-fat diets were not consistently associated with an increased proportion of children at risk for nutritional inadequacy, and higher-fat diets were not consistently protective against inadequacy. Dietary fat could be reduced by judicious selection of lower-fat foods without compromising nutritional adequacy. (J Pediatr 2000;136:181-7)

In view of the heavy burden of cardiovascular disease mortality and obesity-related morbidity in the United States, the American Heart Association, the National Heart, Lung, and Blood Institute, and current federal policy based on Dietary Guidelines for Americans recommend a moderate-fat diet consisting of ≤30% energy from total fat and <10% from saturated fat for everyone over the age of 2 years, with a gradual transition from an unrestricted to a moderate-fat diet occurring between 2 and 6 years.[1-4] Because of concern about the nutritional adequacy of moderate fat diets for children, the American Academy of Pediatrics originally declined to endorse fat-restricted diets for children[5] but adopted these guidelines in 1992.[6,7] The energy and nutrient adequacy of moderate-fat diets for children remains controversial,[8-10] and results of existing studies are inconsistent.[11-21] To date, the nutritional adequacy and other characteristics of moderate-fat diets have not been evaluated in a large, nationally representative sample of US children. Using the Continuing Survey of Food Intakes by Individuals, 1994-96,[22] we classified children from 2 to 8 years old into quartiles of fat intake and compared mean nutrient intakes, proportion of children at risk for inadequate intakes, Food Pyramid servings, and fat content per standard serving across quartiles.

See editorial, p. 143.

From the Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia.

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Reprint requests: Carol Ballew, PhD, Mailstop K-26, 4770 Buford Highway NE, Atlanta, GA 30341.

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AI	Adequate intake
CSFII	Continuing Survey of Food Intake by Individuals
EAR	Estimated average requirement
IOM	Institute of Medicine
RDA	Recommended dietary allowance

Methods

The CSFII 1994-96 was a nationally representative sample of the non-institutionalized US population. Each participant provided 2 nonconsecutive days of 24-hour diet recall. The interviews were divided approximately equally across all 12 months of the year and all 7 days of the week. A parent or other proxy responded for children less than 6 years old; children 6 years and older responded to the 24-hour recall interview themselves with help from their parents. Interviews with day care and school meal providers were conducted as needed to obtain complete descriptions of children's intakes. Interviewers used food models, measuring guides, and an extensive series of standardized probes to improve accuracy and completeness of reporting. Details of the dietary interview protocols and quality assurance procedures have been published.[22] The survey used the United States Department of Agriculture nutrient database with periodic updates during the 3 years of the survey.[22] We included only nutrients derived from food in this analysis because data on the nutrient content of dietary supplements were not available.

Cutpoints defining the risk of inadequate intakes of thiamine, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, and magnesium were based on the Institute of Medicine's age-specific dietary reference intakes by using the Estimated Average Requirement; and for calcium, by using the Adequate Intake.[23,24] Because dietary reference intakes for other nutrients have not yet been released by the IOM, cutpoints for defining the risk of inadequate intakes of protein, vitamin A, vitamin C, vitamin E, iron, and zinc were based on age-specific recommended dietary allowance.[25] The RDA was designed to provide 97.5% of the population with adequate intake of a nutrient, whereas the EAR and the AI approximate population mean requirements.[23-25] Therefore a larger proportion of individuals will fall below the RDA than below the EAR or AI. However, the IOM guidelines for dietary evaluation specify the use of EARs if they are available, AIs if EARs are not available, and RDAs for those nutrients that have not yet been reevaluated.[23,24] For simplicity of presentation, we refer to the intake of a given nutrient falling below its respective cutpoint as *the risk of inadequate intake.* We used the IOM age strata 2 to 3 years (n = 1152) and 4 to 8 years (n = 1650). These samples exclude 4% of children in each age stratum (45 and 61 children, respectively) for whom complete data were not available.

To identify sources of fat, we used the Food Pyramid Serving equivalents provided in the CSFII database.[22] Combination foods were separated into ingredients that were tabulated in serving equivalents. The CSFII database computes discretionary fat (in grams) for all foods by using a standard low-fat reference food in each Food Pyramid category.[22] Discretionary fat is a way to quantify the consumption of higher-fat rather than lower-fat foods from a given food group. For each food group in the Food Pyramid, the fat content of the lowest-fat form was determined and all other foods were assigned a discretionary fat value by subtracting this lowest value from the actual fat content of each food.[22] For example, an 8 oz glass of skim milk contains 0.44 g of fat, whereas a glass of whole milk contains 8.04 g, so the discretionary fat content of whole milk is 7.60 g. The lowest fat contents for the other food groups were 1.01 g per standard serving of grain, 0.22 g per standard serving of vegetables, 0.28 g per standard serving of fruit, and 2.65 g per ounce of cooked meat.[22] We calculated the mean discretionary fat per serving of foods in the standard Food Pyramid groups and in our subcategories. The foods included in this analysis accounted for a mean of 97.6% (SEM .01) of the total fat reported by children 2 to 3 years old, and for 97.4% (SEM .01) of the total fat reported by children 4 to 8 years old.

We subdivided several of the Food Pyramid groups because we were interested in the contribution of specific foods to children's fat intakes: pastries (cakes, pies, cookies, and similar foods) and snacks (crackers, potato chips, popcorn, and similar foods) within grains, and french fries within vegetables. Potato chips are coded as a vegetable in the CSFII database but we deleted them from our vegetable count and included them in snacks instead. We created a category of fat-based condiments (butter, margarine, mayonnaise, sour cream, and salad dressings). For the purposes of comparing condiment intake across fat quartiles, we arbitrarily defined a serving as 1 tablespoon.

We calculated the estimated usual nutrient intakes and the proportion of children with intakes below IOM or RDA cutpoints with SIDE/IML software (Iowa State University Statistical Laboratory, Ames, Iowa). This software computes the intraindividual variation reflected in 2 days of diet records and uses it to estimate the usual intake per person; the estimated usual intake provides a better approximation of the true distribution of intakes across a sample.[26] The resulting narrower distribution of estimated usual intake is especially important when examining the proportion of respondents who fall below cutpoints in a distribution such as the EAR or the RDA. We classified dietary fat intakes by quartile of percent energy from total fat. The quartile categories were nearly identical for the 2 age groups and were rounded to ≤28.9% (lower limit 18%, median 27%), 29.0% to 31.9% (median 30%), 32.0% to 34.9% (median 33.5%), and ≥35.0% (median 37%, upper limit 48%). Quartile 2 brackets the recommended 30% of energy from fat; we defined it as moderate fat intake and used it as the reference category for analysis.

We compared nutrient intakes and standard Food Pyramid servings among the groups with tests for trend across the 4 quartiles and with *t* tests comparing quartile 2 with other quartiles if tests for trend were nonsignificant. We compared the proportion of children consuming less than the age-specific EARs or RDAs[23-25] across dietary fat intake quartiles with tests for trend across the quartiles and with χ^2 comparing quartile 2 with other quartiles. The data set was created with SAS software (SAS Institute, Cary, NC). Analyses were performed with SIDE/IML[26] and SUDAAN[27] software, taking into account the complex sample design by using sample weights and strata provided in the data set.

RESULTS

The sex ratio and age distribution did not differ significantly among fat

Table I. Mean estimated usual nutrient intakes of children aged 2 to 8 years by quartile of fat intake in the CSFII 1994-96

	Children aged 2 to 3 y				Children aged 4 to 8 y			
	FIQ 1	FIQ 2	FIQ 3	FIQ 4	FIQ 1	FIQ 2	FIQ 3	FIQ 4
Energy (kcal)	1305.0 (16.5)	1435.3 (22.3)	1430.0 (28.1)	1452.3 (21.7)*	1548.9 (30.7)	1665.8 (17.8)	1812.5 (22.2)	1792.5 (21.4)*
Protein (g)	45.6 (0.6)	49.8 (0.8)	51.8 (1.1)	53.6 (1.0)*	51.6 (1.0)	57.0 (0.7)	65.0 (0.6)	64.7 (1.0)*
Total fat (g)	35.8 (0.1)	47.3 (0.4)	54.4 (0.9)	64.5 (1.0)*	41.9 (0.3)	55.1 (0.2)	68.9 (0.5)	78.6 (0.8)*
Saturated fat (g)	13.8 (0.1)	18.1 (0.2)	21.1 (0.3)	24.4 (0.4)*	15.4 (0.1)	20.4 (0.2)	25.7 (0.2)	29.4 (0.4)*
Cholesterol (mg)	127.0 (2.8)	167.9 (2.7)	187.5 (4.9)	224.2 (5.5)*	127.3 (3.2)	172.7 (2.4)	223.2 (3.4)	245.3 (3.8)*
Fiber (g)	10.3 (0.2)	10.3 (0.2)	9.4 (0.3)†	8.6 (0.2)†	12.0 (0.3)	11.7 (0.2)	12.1 (0.2)	11.1 (0.2)‡
Vitamin A (µg RE)	788.4 (15.5)	761.1 (16.2)	694.9 (15.2)	617.4 (11.4)*	856.9 (24.7)	848.8 (14.8)	970.8 (31.0)	755.5 (17.6)†
Vitamin C (mg)	121.4 (5.1)	113.5 (2.9)	93.3 (2.7)	72.1 (2.1)*	117.1 (4.8)	102.2 (2.0)	91.5 (1.5)	74.7 (1.5)*
Vitamin E (mg α-TE)	4.2 (0.1)	4.7 (0.1)	4.7 (0.1)	5.6 (0.1)*	4.6 (0.1)	5.4 (0.1)	6.3 (0.1)	6.6 (0.1)*
Thiamine (mg)	1.2 (0.02)	1.2 (0.02)	1.2 (0.02)	1.1 (0.02)	1.5 (0.03)	1.5 (0.02)	1.6 (0.02)‡	1.4 (0.02)
Riboflavin (mg)	1.6 (0.03)	1.7 (0.03)	1.7 (0.03)	1.6 (0.03)	1.8 (0.05)	1.9 (0.03)	2.1 (0.03)†	1.9 (0.03)
Niacin (mg)	13.6 (0.3)	14.4 (0.2)	14.0 (0.3)	14.1 (0.3)	16.8 (0.4)	17.3 (0.2)	19.2 (0.2)†	17.1 (0.3)
Vitamin B_6 (mg)	1.4 (0.03)	1.4 (0.03)	1.3 (0.02)	1.2 (0.02)*	1.5 (0.04)	1.6 (0.02)	1.6 (0.02)	1.4 (0.03)‡
Folate (µg)	195.6 (4.5)	204.6 (4.4)	197.9 (4.9)	175.0 (3.3)†	246.3 (8.0)	235.8 (3.4)	242.8 (3.8)	201.8 (4.1)†
Vitamin B_{12} (µg)	2.8 (0.1)	3.0 (0.1)	3.2 (0.1)	3.4 (0.1)†	3.1 (0.1)‡	3.7 (0.1)	4.6 (0.1)‡	4.0 (0.1)‡
Calcium (mg)	728.7 (12.9)	784.8 (23.1)	779.9 (19.0)	786.4 (18.8)	772.1 (18.8)‡	839.4 (15.7)	896.2 (14.1)‡	876.0 (17.7)
Iron (mg)	10.7 (0.2)‡	11.7 (0.2)	11.1 (0.2)	10.5 (0.2)†	13.7 (0.3)	13.3 (0.2)	14.2 (0.3)‡	12.6 (0.3)
Magnesium (mg)	186.4 (2.9)	193.4 (2.8)	182.3 (4.4)	181.6 (2.8)‡	205.1 (4.2)	209.5 (2.4)	221.3 (2.7)‡	211.3 (3.3)
Zinc (mg)	6.8 (0.1)	7.6 (0.2)	7.9 (0.2)	8.0 (0.2)*	8.5 (0.2)	9.0 (0.1)	9.8 (0.1)†	9.5 (0.2)

Values are expressed as mean with SEM in parentheses.
FIQ, Fat intake quartile; *RE,* retinol equivalent; *α-TE,* α-tocopherol equivalent.
*Test for trend $P < .0001$.
†Significantly different from quartile 2 ($P < .001$).
‡Significantly different from quartile 2 ($P < .01$).

intake quartiles in either age group. Therefore we present results for boys and girls combined and we have not age-standardized the analysis within age group strata.

Tests for trend showed generally strong and highly statistically significant linear trends for mean nutrient intakes across the 4 fat quartiles, although in some cases the mean intakes in any 2 adjacent quartiles were not significantly different (Table I). Energy, protein, total fat, saturated fat, cholesterol, and vitamin E intakes increased significantly ($P < .0001$) across fat quartiles in both age groups, and zinc intake increased significantly across fat quartiles among 2- to 3-year-olds ($P < .0001$). Among 4- to 8-year-olds, children in quartile 2 consumed less thiamine ($P < .01$), riboflavin ($P < .001$), niacin ($P < .001$), calcium, iron, magnesium (all $P < .001$), and zinc ($P < .01$) than children in quartile 3 and less vitamin B_{12} than children in quartiles 3 and 4 (both $P < .01$). In contrast, vitamin C intake decreased significantly across fat quartiles in both age groups, and vitamin A and vitamin B_6 intakes decreased across fat quartiles among children 2 to 3 years of age (all $P < .0001$). Among 2- to 3-year-olds, children in quartile 2 consumed more fiber than children in quartiles 3 or 4 ($P < .001$), more folate than children in quartile 4 ($P < .001$), more iron than children in quartile 4 ($P < .001$), and more magnesium than children in quartile 4 ($P < .01$). Among 4- to 8-year-olds, children in quartile 2 consumed more fiber ($P < .01$), vitamin A ($P < .001$), vitamin B_6 ($P < .01$), and folate ($P < .001$) than children in quartile 4.

The proportion of children at risk for inadequate intake of vitamin E decreased across fat quartiles in both age groups ($P < .001$), and the proportion at risk for inadequate intake of zinc decreased across fat quartiles among 2- to 3-year-olds ($P < .01$) (Table II). Among 4- to 8-year-olds, the proportion of children at risk for inadequate intakes of calcium and zinc was higher in quartile 2 than in quartile 3 ($P < .01$ and $P < .001$, respectively) but not quartile 4. The proportion of children at risk for inadequate vitamin A and vitamin C intakes increased across fat quartiles among 2- to 3-year-olds ($P < .001$). Among 4- to 8-year-olds, the proportion of children at risk for inadequate vitamin A intake was lower in quartile 2 than in quartile 4 ($P < .001$) and the proportion of children at risk for inadequate vitamin C intake was lower in quartile 2 than in quartiles 3 or 4 (both $P < .001$). The proportion of children at risk for inadequate folate intake was lower in quartile 2 than in quartile 1 or quartile 4 (both $P < .01$).

The number of servings of fruit per day decreased significantly across fat quartiles ($P < .001$), although the number of servings of vegetables ($P < .01$ for 2- to 3-year-olds, $P < .001$ for 4- to 8-year-olds), meat ($P < .001$), and fat-

Table II. Proportion of children aged 2 to 8 years consuming less than standard intake of selected nutrients by quartile of fat intake in the CSFII 1994-96

	Children aged 2 to 3 y				Children aged 4 to 8 y			
	FIQ 1	FIQ 2	FIQ 3	FIQ 4	FIQ 1	FIQ 2	FIQ 3	FIQ 4
Percent of children below standard intake								
Vitamin A	4.0	5.6	8.1	13.5*	36.4	32.9	30.4	47.5†
Vitamin C	1.8	1.4	4.3	16.1*	3.7	2.1	11.1†	12.0†
Vitamin E	93.9	83.8	82.9	63.7*	96.8	90.2	70.6	60.6*
Folate	11.0	8.3	10.3	12.3	20.9‡	18.7	14.0	23.7‡
Calcium	12.1	16.5	14.9	16.1	59.8	50.1	38.0‡	41.2
Iron	48.6	40.4	41.5	45.9	15.9	17.2	11.7	22.8
Magnesium	0	0	0	0.8	1.2	1.2	0.6	0.9
Zinc	93.6	88.6	81.9	83.0§	77.3	72.3	58.1†	62.1

Standard intake was defined as 100% of the RDA[24] for vitamin A, vitamin C, vitamin E, iron, and zinc; as 100% of the EAR[22,23] for folate and magnesium; and as 100% of the AI[24] for calcium. Fewer than 1% of children in any quartile were below 100% of the RDA for protein or below 100% of the EAR for thiamine, niacin, riboflavin, vitamin B_6, or vitamin B_{12}.
FIQ, Fat intake quartile.
*Test for trend ($P < .0001$).
†Significantly different from quartile 2 ($P < .001$).
‡Significantly different from quartile 2 ($P < .01$).
§Test for trend ($P < .001$).

Table III. Food pyramid servings of children aged 2 to 8 years by quartile of fat intake in the CSFII 1994-96

	Children aged 2 to 3 y				Children aged 4 to 8 y			
	FIQ 1	FIQ 2	FIQ 3	FIQ 4	FIQ 1	FIQ 2	FIQ 3	FIQ 4
Servings								
Grains	4.3 (0.1)	4.7 (0.1)	4.6 (0.2)	4.3 (0.1)	6.0 (0.2)	5.7 (0.1)	6.2 (0.2)	5.5 (0.1)
Snacks	0.6 (0.1)	0.5 (0.1)	0.5 (0.1)	0.5 (0.1)	0.7 (0.2)	0.6 (0.1)	0.6 (0.2)	0.5 (0.1)
Pastries	0.3 (0.1)	0.3 (0.1)	0.3 (0.1)	0.4 (0.1)	0.4 (0.1)	0.5 (0.1)	0.5 (0.1)	0.5 (0.1)
Fruit	2.7 (0.2)	2.1 (0.1)	1.6 (0.1)	1.1 (0.2)*	2.3 (0.2)	1.8 (0.1)	1.4 (0.1)	1.1 (0.2)*
Vegetables	1.3 (0.1)	1.6 (0.1)	1.7 (0.1)	1.8 (0.1)†	1.6 (0.1)	1.8 (0.1)	2.1 (0.1)	2.1 (0.1)*
French fries	0.2 (0.1)	0.3 (0.1)	0.4 (0.1)	0.4 (0.1)*	0.2 (0.1)	0.3 (0.1)	0.5 (0.1)‡	0.4 (0.1)
Dairy	1.3 (0.1)	1.5 (0.1)	1.5 (0.1)	1.6 (0.1)	1.4 (0.1)	1.6 (0.1)	1.6 (0.1)	1.6 (0.1)
Meat	1.2 (0.1)	1.7 (0.1)	2.1 (0.1)	2.4 (0.1)*	1.6 (0.1)	2.0 (0.1)	2.6 (0.1)	3.0 (0.1)*
Fat-based condiments	1.1 (0.1)	2.0 (0.3)	2.5 (0.2)	2.9 (0.3)*	2.0 (0.2)	3.1 (0.3)	3.5 (0.3)	4.8 (0.4)*
Discretionary fat (g)	24.0 (0.5)	33.9 (0.8)	40.5 (1.2)	48.6 (1.1)*	29.3 (1.0)	39.8 (0.7)	49.7 (0.9)	58.0 (1.0)*

Values are expressed as mean with SEM in parentheses.
FIQ, Fat intake quartile.
*Test for trend ($P < .0001$).
†Test for trend ($P < .001$).
‡Significantly different from quartile 2 ($P < .01$).

based condiments ($P < .001$) increased (Table III). The grams of discretionary fat consumed per day also increased significantly across fat quartiles ($P < .001$). The number of servings of grains, the servings of snacks and pastries within the grains category, and the number of servings of dairy products did not differ significantly across fat quartiles. The mean fat content per serving of grain increased significantly across fat categories ($P < .001$), but the mean fat content of snacks or pastries within the grain category did not differ (Table IV). The mean fat content per serving of vegetables, and of french fries within the vegetable category, increased significantly across fat quar-

Table IV. Mean fat content of food servings of children aged 2 to 8 years by quartile of fat intake in the CSFII 1994-96

	Children aged 2 to 3 y				Children aged 4 to 8 y			
	FIQ 1	FIQ 2	FIQ 3	FIQ 4	FIQ 1	FIQ 2	FIQ 3	FIQ 4
Discretionary fat per serving (g)								
Grain	2.8 (0.1)	3.1 (0.1)	3.2 (0.1)	3.5 (0.1)*	2.8 (0.1)	3.2 (0.1)	3.3 (0.1)	3.5 (0.1)*
Snacks	2.2 (0.2)	2.8 (0.2)	2.8 (0.2)	3.0 (0.2)	2.4 (0.1)	3.1 (0.2)	3.0 (0.2)	2.9 (0.2)
Pastries	5.0 (0.4)	6.3 (0.5)	5.8 (0.3)	6.4 (0.6)	5.3 (0.4)	6.3 (0.4)	6.5 (0.4)	6.6 (0.5)
Vegetables	1.5 (0.1)	1.9 (0.1)	2.4 (0.2)	3.2 (0.1)*	1.7 (0.1)	2.1 (0.1)	2.4 (0.1)	2.7 (0.1)*
French fries	0.9 (0.1)	1.2 (0.1)	1.5 (0.1)	1.5 (0.1)†	0.9 (0.1)	1.4 (0.1)	1.7 (0.1)	1.5 (0.1)†
Dairy	5.5 (0.2)	6.5 (0.2)	7.8 (0.3)	7.5 (0.2)*	5.4 (0.3)	7.3 (0.5)	7.2 (0.2)	7.7 (0.2)*
Meat	6.2 (0.2)	7.0 (0.2)	7.1 (0.2)	8.1 (0.2)*	6.3 (0.3)	6.4 (0.2)	7.0 (0.2)	7.7 (0.2)*

Values are expressed as mean with SEM in parentheses.
FIQ, Fat intake quartile.
*Test for trend $P < .0001$.
†Test for trend $P < .001$.

tiles ($P < .001$ and $P < .01$, respectively), as did the mean fat content per serving of dairy products and meat (both $P < .001$).

Discussion

We found little support for the supposition that diets with a moderate fat content (ie, quartile 2, 29.0% to 31.9% of energy from total fat) are consistently lower in nutrient content than higher-fat diets. More children with moderate fat intakes were at risk for inadequate intakes of vitamin E and zinc than children in higher quartiles in both age groups, and for inadequate intake of calcium among 4- to 8-year-olds, but more children with higher fat intakes were at risk for inadequate intakes of vitamins A and C than children in quartile 2 in both age groups, and for inadequate intake of folate among 4- to 8-year-olds. The higher-fat diets were not consistently protective against potential nutrient inadequacy. The definitions of risk of inadequate intakes for vitamins A, C, and E, iron, and zinc were based on the RDA,[25] which is intended to provide adequate intakes for 97.5% of the population. In contrast, the definition of inadequate intakes was based on the EAR for the B vitamins and magnesium and on the AI for calcium, which are lower than the RDA[23,24] and approximate the mean requirement of the population. Therefore the risks of inadequate intakes of the various nutrients should not be compared directly and it would be inappropriate to try to determine whether the effects of fat intake were greater for one nutrient than for another. However, the focus of this analysis was the comparison of the proportion of children at risk for inadequate intakes of individual nutrients across quartiles of fat intake.

In the Bogalusa Heart Study, children with the lowest fat intakes (<30% of energy) were more likely than children with the highest fat intakes (>40%) to have nutrient intakes below the RDA.[12] It is difficult to make a direct comparison with our results because the CSFII survey is designed to be representative of the population of the United States as a whole, whereas the Bogalusa sample was drawn from a limited geographic area. In addition, the authors discussed only the comparison of their highest and lowest fat intake categories, corresponding to less than the median of our quartile 2 and well above the median of our quartile 4, and they did not provide a test for trend across the full range of fat intakes in their sample. In a longitudinal study of 215 free-living children 3 to 4 years old at baseline, who were not participating in a dietary intervention, Shea et al[21] found no differences in growth between children with fat intakes ranging from 28% to 38% of energy. They also found that children reporting mean intakes of <30% of energy from fat had significantly lower calcium intakes but higher intakes of iron, thiamine, niacin, and vitamins A and C than children reporting mean intakes of >32% of energy from fat. Their study is especially convincing because the dietary intake estimates were based on four 24-hour recalls and three food frequency questionnaires collected over a 25-month period. The case reports of children exhibiting growth failure on very low fat diets[28,29] reflect inappropriate diet regimens, including severe caloric restriction imposed without medical supervision; they are not generalizable to children with moderate fat intakes.

Our analysis of CSFII data is cross sectional. Although the CSFII 1994-96 obtained 2 nonconsecutive days of recall per participant, it may still have failed to capture the full range of day-to-day variation in children's eating patterns, often referred to as usual intake. In addition, analyses based on only one or two recalls tend to overestimate the proportion of children who consume less than any specific cut-point value for vitamins and minerals.[30] We used software and computational algorithms designed to improve the estimate of the usual intake of nutrients and to yield more accurate estimates of the proportions of children below cutpoints in distributions.[26] Another potential source of error in our study is the possibility of inaccurate or incomplete reporting of 24-hour diet intakes by the parents and children included in the sample. Parents, children aged 6 years and older, and day-care and school meal providers were all interviewed to obtain as complete and accurate a recall as possible.[22] However, all these potential sources of error in our analysis apply equally to all of the children included in the survey, so our comparison of nutrient intakes by fat quartile should not be biased.

Our results are based only on reported food intakes. We would have liked to include the nutrient contribution of dietary supplements the children might have been taking, but data on the nutrient contents of supplements were not reported in the data set. Other surveys have shown that between 35% and 55% of children in the age range we considered use multivitamins or other supplements.[31,32] In our sample 37% of the children reported taking some form of dietary supplement daily and 16% reported taking supplements occasionally. The most common supplements were multivitamins and vitamin C; other supplements were uncommon. The prevalence of supplement use did not differ across fat intake quartiles for either age group (data not shown). It is difficult to determine whether children who receive supplements are those at higher risk for low nutrient intakes from food, although one investigation showed that children who receive dietary supplements are of higher socioeconomic status than those who do not.[33]

In our sample, fruit consumption decreased across quartiles of dietary fat intake, whereas the consumption of vegetables, meat, and fat-based condiments increased. The mean fat content per serving of grain, vegetables, dairy products, and meat also increased across quartiles. The increasing fat content of grain servings across quartiles was not associated with differences in the fat content of snacks or pastries, so it was attributable to higher-fat selections among such foods as breads and cereals. The increasing fat content per serving of vegetables other than french fries was attributable to preparation methods rather than condiment use, because fat-based condiments such as butter, margarine, sour cream, or dressings that might have been added to vegetables at the table were tabulated separately. Within the french fries category, differences in mean fat content per serving were associated with preparation methods such as oven baking versus deep frying. The higher fat content of dairy products and meats consumed by children who had higher fat intakes was attributable to both higher-fat choices (eg, whole milk products or fatty cuts of meat) and preparation methods such as frying rather than baking or broiling (data not shown).

Children with higher fat intakes did not obtain more discretionary fat than other children from greater consumption of snacks and pastries, or even largely from greater use of fat-based condiments, which accounted for only 7% of the total fat reported. The children got more than 90% of their greater discretionary fat intake from food groups that are the basis of a prudent diet. They consumed higher-fat rather than lower-fat foods within a group, such as whole milk dairy products rather than lower-fat dairy products, and they consumed foods prepared by methods like frying that added fat. Limiting high-fat condiments and substituting lower-fat food choices and lower-fat preparation methods would reduce total fat intake with little impact on the nutrient adequacy of diets. Birch et al[34] found that young children can spontaneously regulate their overall energy intake over a day when dietary fat content is manipulated, increasing their energy intake from nonfat sources when fat content is reduced. Dwyer[35] demonstrated that menus can be designed to provide children with a selection of lower-fat, nutrient-dense foods that achieve adequate energy and nutrient intakes while maintaining a moderate fat intake. Our results suggest that free-living US children who spontaneously consume diets with approximately 30% of energy from fat are not at increased risk for low nutrient intakes relative to children who consume higher fat diets, with the exception of vitamin E, calcium, and zinc, nutrients for which many children in all fat intake quartiles were at risk. We also found that children with moderate-fat diets were at lower risk for low intakes of vitamin A, vitamin C, and folate than children with higher fat diets.

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